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Propagation of pistachio *Pistacia vera* L. by air layering under the effects of IBA and GA_3 treatments

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Abstract

This research was conducted in the College of Agricultural Sciences Engineering, University of Sulaimani, Kurdistan region/ Iraq, to study the possibility of propagation of pistachio *Pistacia vera* cv. Batoury by air layering through treating the girdling wounds with IBA, and spray of layered shoots with IBA and GA_3. The experiment was laid out by RCBD design with three replications on six trees. 20000 ppm IBA applied to the girdling wounds of layered shoots gave values of rooting percentage (63%), root number (4.6), root length (5.7 cm) and survival percentage (80%), while control gave no rooting. The rooting percentage of (33.4%) was achieved from layered shoots without spray and from those sprayed by 25 and 50 ppm IBA. A survival percentage of (50%) was achieved from layered shoots sprayed by 25, 50 ppm IBA and 30 ppm GA_3. Interaction of 20000 ppm IBA treatment of girdling wound with 25 and 50 ppm IBA spray of layered shoots and without spray gave (70%) rooting percentage. 20000 ppm IBA treatment of girdling wound with spray of layered shoots by 25, 50 ppm IBA and 30 ppm GA_3 showed the highest (100%) survival percentage.

Keywords: propagation, pistachio, *Pistacia vera,* air layering, IBA, GA_3 treatments

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INTRODUCTION

The best way for propagating *Pistacia vera* L. is vegetative propagation method, because *Pistacia vera* is a dioecious fruit, male and female flowers are produced on different trees, and the sex type of the trees could be determined through this method in which the new produced clones preserve their genetic properties as in the stock plant. Inefficient methods of vegetative propagation in pistachio have limited plantation expansion (Tilkat et al. 2009). Vegetative propagation of pistachio remains difficult, because pistachio trees are heterogeneous and cuttings of them are difficult to root, despite commercial varieties are propagated by grafting and budding onto rootstocks, but they are slow and the presence of resin impedes the union of the scion and rootstock (Barghchi and Alderson 1983, Chatibi et al. 1994, Filatov et al. 2018, Hall 1975, Joley and Opits 1971, Kvon et al. 2017, Yorov et al. 2019, Zaitseva et al. 2018). However, *Pistacia vera* is propagated by tissue culture, but it is expensive and requires many equipment and facilities.

Alternatively, propagation by layering is another vegetative method which is used to propagate difficult-to-root species, in which adventitious roots induced to form on stems still attached to mother plant (Beyl and Trigiano 2016). For propagating pistachio species by layering, Dunn and Cole (1995) reported the possibility of propagating *Pistacia chinensis* successfully by mound layering.

Air layering is one of the types of propagation layering used in deciduous fruits. Fruit trees such as peaches, plums, cherries, pomegranates and figs were successfully propagated by this method (Moreira et al. 2009, Patel et al. 2012, Reddy et al. 2014). Interruption of phloem and hence the accumulation of carbohydrates, proteins, root-promoting factors, auxins and ethylene at girdling area, also increasing the cellular activities such as higher respiratory rate and formation of callus, which consequently led to root formation, are the principles of plant propagation by layering (Hartmann et al. 2011). Castro and Silveira (2003) reported that IBA was an effective factor for rooting in air layering propagation of peach when it was applied to the

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Table 1. Effect of IBA treatment of girdling wounds of *Pistacia vera* L. cv. Batoury layered shoots as propagated by air layering

Girdling wound treatments	Rooting%	Root number	Root length (cm)	Survival %
Control	0.00 b †	0.00 b	0.00 b	0.00 b
20000 IBA	63.00 a	4.10 a	4.80 a	80.00 a

† The values in each column with the same letter do not differ significantly ($P \leq 0.05$) according to Duncan's Multiple Range Test.

wounding area by dropping. On the other hand, Davies and Hartmann (1988) denoted that spray of the stock plant by plant growth regulators (PGRs) improved physiological states of propagules to form adventitious roots. Also, Read and Yang (1989) summarized that PGRs applied to stock plant enhanced rooting of macropropagules and micropropagules. In this regard, Pacholczak et al. (2005) mentioned that spraying stock plants with IBA or NAA in the range of concentrations of 50-500 mg dm^{-3} were effective in propagation of ornamental shrubs by stem cuttings. Moreover, pre-treatment of gibberellin (GA_3) for stock plant improved rooting and shoot growth rates in cuttings of *Prunus avium* (Ford et al. 2002). Therefore, the aim of this study is to evaluate air layering of *Pistacia vera* under the effects of treatments of girdling wound with and without IBA and spray of layered shoots with IBA and GA_3.

MATERIALS AND METHODS

This research was conducted to investigate the possibility of propagation of pistachio *Pistacia vera* L. cv. Batoury by air layering through treating the girdled wounds with and without IBA, and spray of layered shoots with IBA and GA_3 in the College of Agricultural Sciences Engineering, University of Sulaimani, Kurdistan region/ Iraq. The experiment was laid out by RCBD design with three replications on six trees (two males and four females), each two trees were considered as one block.

One-year-old shoots with 0.9-1.3 cm in diameter were girdled on April 1, 2018 by removing 1 cm of the barks at 25 cm length from the shoot tips, the girdled wounds were treated with (0 and 20000 ppm IBA) by dissolving IBA in 50% ethanol, then the girdled wounds were enclosed with moist peat and wrapped by polyethylene bags then covered to prevent penetration of light. After a week, the layered shoots were sprayed by (0, 30, 50 ppm GA_3 and 25, 50 ppm IBA) with 15 days interval until July 1. Every 30 days, 30 ml of water were added to the peat around girdling region by a syringe.

On July 1, the study was terminated and the layered shoots were excised from the containers to observe and measurement of the propagation parameters (rooting percentage, number of the main roots and length of the longest root). After that, the excised shoots transplanted to the plastic bag contained peat + perlite + sand by 2:1:1, and placed in a greenhouse with 23-34 °C. After 50 days, survival percentages were calculated.

RESULTS AND DISCUSSION

According to the results showed in **Table 1**, 20000 ppm IBA applied to the girdling wound of layered shoots of *Pistacia vera* L. cv. Batoury was more effective and gave (63%) rooting percentage, and the same IBA concentration gave the best root number (4.1), root length (4.8 cm) and survival percentage (80%). While control gave no rooting. These results may be due to that the wounds made by girdling facilitated the penetration of IBA into rooting initiation zone in which induced cell division and root formation (Prolingis et al. 1999). Cameron (1970) also found the accumulation of photosynthates at the root initiation site, as a result of girdling which was enhanced by application of IBA to the base of the girdled *Pinus radiata* shoots. In another research, Van der Krieken et al. (1993) reported that application of exogenous IBA improved rooting via increasing internal free IBA, converted IBA to physiologically active IAA, or may synergistically modify the action or endogenous synthesis of IAA Simelane et al. (2016).

Table 2 shows that the highest value of rooting percentage (33.4%) was achieved from layered shoots without spray and from those sprayed by 25 and 50 ppm IBA, whereas GA_3 spray gave (20.2%) rooting percentage. The best survival percentage (50%) was achieved from layered shoots sprayed by 25, 50 ppm IBA and 30 ppm GA_3, this may be due to those shoots gave the best root numbers (4.00, 2.12 and 3.00, respectively as shown in the same table), thereby more nutrients could be absorbed, this is supported by Singh and Bhuj (2000) who mentioned that the higher survival percentage of layered guava may relate to maximum root characters (number, length and diameter of roots). While, the effect of IBA spray may be attributed to the results achieved by Kroin (2009) who noticed that leaves can take aqueous auxins from a solution which contained free auxin through stomatal pores, and transported by vascular system like natural auxins, accumulated and utilized at the basal end, when it used for root initiation. Whereas, the effect of GA_3 spray on layered shoots may be attributed to that GA_3 worked through increasing endogenous IAA, in this aspect, Law and Hamilton (1984) found that GA_3 spraying increased endogenous IAA in dwarf peas by 8-fold. Furthermore, Wang et al. (1995) demonstrated that application of GA can promote xylem and phloem production, provided and elevated IAA at cambial region. Additionally, photosynthates accumulated in stem is controlled by using GA_3 (Hayes and Patrick 1985).

Table 2. Effect of IBA and GA_3 spray of layered shoots of *Pistacia vera* L. cv. Batoury as propagated by air layering

Layered shoot sprays	Rooting%	Root number	Root length (cm)	Survival%
Without spray	33.40 a †	1.42 bc	3.08 a	25.00 b
25 ppm IBA	33.40 a	4.00 a	2.81 a	50.00 a
50 ppm IBA	33.40 a	2.12 b	3.27 a	50.00 a
30 ppm GA_3	20.20 b	3.00 a	2.92 a	50.00 a
50 ppm GA_3	20.20 b	0.60 c	2.25 a	25.00 b

† The values in each column with the same letter do not differ significantly (*P*≤0.05) according to Duncan's Multiple Range Test.

Table 3. Interaction effects of IBA treatment of girdling wound and spray of *Pistacia vera* L. cv. Batoury layered shoots by IBA and GA_3 as propagated by air layering

Girdling wound treatments	Layered shoot sprays	Rooting%	Root number	Root length (cm)	Survival%
Control	Without spray	0.00 c †	0.00 c	0.00 c	0.00 c
	25 ppm IBA	0.00 c	0.00 c	0.00 c	0.00 c
	50 ppm IBA	0.00 c	0.00 c	0.00 c	0.00 c
	30 ppm GA_3	0.00 c	0.00 c	0.00 c	0.00 c
	50 ppm GA_3	0.00 c	0.00 c	0.00 c	0.00 c
20000 ppm IBA	Without spray	70.00 a	3.10 b	6.17 ab	50.00 b
	25 ppm IBA	70.00 a	8.00 a	5.62 ab	100.00 a
	50 ppm IBA	70.00 a	4.20 b	6.55 a	100.00 a
	30 ppm GA_3	45.00 b	5.80 ab	5.85 ab	100.00 a
	50 ppm GA_3	45.00 b	1.14 bc	4.50 ab	50.00 b

† The values in each column with the same letter do not differ significantly (*P*≤0.05) according to Duncan's Multiple Range Test.

Interaction effects of IBA treatment of girdling wound and spray of layered shoots of *Pistacia vera* L. with IBA and GA_3 are shown in **Table 3** which demonstrates that the interaction of 20000 IBA treatment of girdling wound with 25 and 50 ppm IBA sprays of layered shoots and without spray gave the highest values (70%) of rooting percentages, while 20000 IBA treatment of girdling wound with 30 and 50 ppm GA_3 sprays of layered shoots gave (45%) rooting percentage. The highest root number (8.00) was achieved from interaction of 20000 IBA treatment of girdling wound with spray of layered shoots by 25 ppm IBA. Interaction effects of the two factors were not significant on root length. Interaction effects of 20000 IBA treatment of girdling wound with spray of layered shoots by 25, 50 ppm IBA and 30 ppm GA_3 showed the highest (100%) survival percentage. Control (girdling wounds without IBA treatment) gave no results either with spray treatments or without spray of layered shoots Peluola-Adeyemi et al. (2016).

CONCLUSION

IBA is more significant in the air layering propagation of *Pistacia vera* L. cv. Batoury by treating the girdling wound of layered shoots. 20000 ppm IBA gave (63%) rooting percentage, while the control treatment gave no rooting. Layered shoots sprayed with 25 or 50 ppm IBA and those without IBA sprays showed (33.4%) rooting percentage. The highest rooting percentage (70%) was achieved from interaction of 20000 IBA treatment of girdling wound with 25 and 50 ppm IBA spray of layered shoots and without spray. It is important to mention that IBA treatment in a high concentration during layering is recommended instead of low concentration sequential spray treatments.

REFERENCES

Barghchi M, Alderson PG (1983) In vitro propagation of Pistacia species. Acta Horticulturae, 131: 49-60. https://doi.org/10.17660/ActaHortic.1983.131.4

Beyl CA, Trigiano RN (Eds.) (2016) Plant Propagation Concepts and Laboratory Exercises. CRC Press.

Cameron RJ (1970) Translocation of carbon-14-labelled assimilates in shoots of Pinus radiata: the effects of girdling and indole butyric acid. Journal of Experimental Botany, 21(4): 943-950. https://doi.org/10.1093/jxb/21.4.943

Castro LASD, Silveira CAP (2003). Vegetative propagation of peach by air layering technique. Revista Brasileira de Fruticultura, 25(2): 368-370. https://doi.org/10.1590/S0100-29452003000200051

Chatibi A, Kchouk ME, Ben Abdallah F, Zemni H, Ghorbel A (1994) Rooting improvement of Pistacia vera L. cv. Mateur by in vitro culture of apices and cuttings. In: I International Symposium on Pistachio, 419 (pp. 213-220). https://doi.org/10.17660/ActaHortic.1995.419.34

Davies Jr FT, Hartmann HT (1988) The physiological basis of adventitious root formation. Acta Horticulturae, 227: 113-120. https://doi.org/10.17660/ActaHortic.1988.227.17

Dunn DE, Cole JC (1995) Propagation of Pistacia chinensis by mound layering. Journal of Environmental Horticulture, 13(2): 109-112.

Filatov VV, Zaitseva NA, Larionova AA, Zhenzhebir VN, Polozhentseva IV, Takhumova OV, Kolosova GM (2018) State management of plastic production based on the implementation of UN decisions on environmental protection. Ekoloji, 27(106), 635-642.

Ford YY, Taylor JM, Blake PS, Marks TR (2002) Gibberellin A3 stimulates adventitious rooting of cuttings from cherry (Prunus avium). Plant Growth Regulation, 37(2): 127-133. https://doi.org/10.1023/A:1020584627919

Hall WJ (1975) Propagation of walnuts, almonds and pistachios in California. Proc. Intern. Plant Prop. Soc., 25: 53-57.

Hartmann HT, Kester DE, Davies Jr FT, Geneve RL (2011) Plant Propagation: Principles and Practices. 8th ed. New Jersey, Prentice Hall, 915 p.

Hayes PM, Patrick JW (1985) Photosynthate transport in stems of Phaseolus vulgaris L. treated with gibberellic acid, indole-3-acetic acid or kinetin. Planta, 166(3): 371-379. https://doi.org/10.1007/BF00401175

Joley LE, Opits KW (1971) Further experiences with propagation of Pistacia. Combined Proc. Intern. Plant Prop. Soc., 21: 67-76.

Kroin J (2009) Propagation of plants from cuttings using rooting solutions by foliar methods. Comb. Proc. Int. Plant Prop. Soc., 59: 437-453.

Kvon GM, Faleeva LV, Pyrkova GK, Alyakina DP, Mustafina AA, Kryukova NI, Blekus VV (2017) Strategic priorities of regional investment activity. Eurasian Journal of Analytical Chemistry, 12(7): 1099-1106. https://doi.org/10.12973/ejac.2017.00235a

Law DM, Hamilton RH (1984) Effects of gibberellic acid on endogenous indole-3-acetic acid and indoleacetyl aspartic acid levels in a dwarf pea. Plant Physiology, 75(1): 255-256. https://doi.org/10.1104/pp.75.1.255

Moreira O, Martins J, Silva L, Moura M (2009) Propagation of the endangered Azorean cherry Prunus azorica using stem cuttings and air layering. Arquipélago-Life and Marine Sciences: 9-14.

Pacholczak A, Szydło W, Łukaszewska A (2005) Effectiveness of foliar auxin application to stock plants in rooting of stem cuttings of ornamental shrubs. Propagation of Ornamental Plants, 5(2): 100-106.

Patel DM, Nehete DS, Jadav RG, Satodiya BN (2012) Effect of PGR's and rooting media on air layering of different pomegranate (Punica granatum L.) cultivars. Asian Journal of Horticulture, 7(1): 89-93.

Peluola-Adeyemi OA, Obi TE, Ugbogu DI (2016) Effect of Temperature and Time on the Physical Properties of Bread Produced from Wheat–Cocoyam Flour Using Response Surface Methodology. Journal of Food Technology Research, 3(2), 63-71. https://doi.org/10.18488/journal.58/2016.3.2/58.2.63.71

Read PAULE, Yang G (1989) Influencing propagation by stock plant PGR treatments. Acta Horticulturae, 251: 121-128. https://doi.org/10.17660/ActaHortic.1989.251.18

Reddy PPN, Ray NR, Patel AD, Patel JS (2014) Effect of rooting media and IBA (indole butyric acid) levels on rooting and survival of air layering in fig (Ficus carica L.) cv. Poona under middle Gujarat agro-climatic conditions. Asian Journal of Horticulture, 9(1): 1-5.

Simelane MM, Masuku MB, Rugambisa JI, Earnshaw DM (2016) Analysis of Consumer Willingness to Pay for Genetically Modified Maize Food in Swaziland. International Journal of Sustainable Agricultural Research, 3(1), 19-28. https://doi.org/10.18488/journal.70/2016.3.1/70.1.19.28

Singh DK, Bhuj BD (2000) Response of air layering of guava to paclobutrazol and coloured polywrappers. Agric. Sci. Digest., 20(3): 171-173. https://doi.org/10.1097/00132582-200020040-00020

Tilkat E, Onay A, Yıldırım H, Ayaz E (2009) Direct plant regeneration from mature leaf explants of pistachio, Pistacia vera L., Scientia Horticulturae, 121(3): 361-365. https://doi.org/10.1016/j.scienta.2009.02.007

Van der Krieken WM, Breteler H, Visser MH, Mavridou D (1993) The role of the conversion of IBA into IAA on root regeneration in apple: Introduction of a test system. Plant Cell Reports, 12(4): 203-206. https://doi.org/10.1007/BF00237054

Wang Q, Little CHA, Odén PC (1995) Effect of laterally applied gibberellin A4/7 on cambial growth and the level of indole-3-acetic acid in Pinus sylvestris shoots. Physiologia Plantarum, 95(2): 187-194. https://doi.org/10.1111/j.1399-3054.1995.tb00826.x

Yorov JN, Zaitseva NA, Larionova AA, Povorina EV, Chudnovskiy AD, Dmitrieva NV, Takhumova OV (2019) Prospects of preservation of biological system of regions due to development of ecological tourism in the Republic of Tajikistan. Ekoloji, 28(107), 85-91.

Zaitseva NA, Larionova AA, Filatov VV, Rodina EE, Zhenzhebir VN, Povorina EV, Palastina IP (2018) Natural-resource potential management of region's territorial ecosystems. Ekoloji, 27(106): 495-502.